



Office of Prevention, Pesticides,
and Toxic Substances

PC Code: 009001
DP Code: D282004

MEMORANDUM

DATE: April 25, 2002

SUBJECT: Estimated Concentrations of Lindane in Surface Water Used as a Source of Drinking Water From Use and Disposal of Shampoo and Lotion Into Household Wastewater

TO: Betty Shackleford, Branch Chief
M. Howard, Team Leader
Reregistration Branch III
Special Review and Reregistration Division (7508C)

FROM: Faruque A. Khan, Ph.D., Environmental Scientist
Environmental Fate and Effects Division (7507C)

THROUGH: Mah T. Shamim, Ph.D., Chief
Jean Holmes, DMV, MPH, RAPL
Environmental Risk Branch V
Environmental Fate and Effects Division (7507C)

Exposure Conclusions

This memo presents the screening estimated concentrations of lindane in surface water used as a source of drinking water from consumer use for both lice and scabies treatments. Surface water concentrations were based on the estimated annual production volume directed to this market and released into household wastewater from products containing lindane at a maximum concentration of 1 percent. Exposures are further based on the effects of treatment in a Publically Owned Treatment Works (POTW) with a minimum of secondary treatment using either trickling filter or activated sludge bioreactors. Both daily per capita release into the waste stream and the daily per capita wastewater volume release are used in estimating time-averaged surface water concentrations. Estimated surface water concentrations are, **acute 4.41E-04 µg L⁻¹** based on a high-end stream dilution factor (i.e., upper 10th percentile) and **chronic 3.4E-05 µg L⁻¹** based on the median stream dilution factor (i.e., 50th percentile), Table 1.

Table 1. Recommended Lindane Surface Water Drinking Water Concentrations from Household Releases.

Exposure	Estimated Drinking Water Concentrations ($\mu\text{g L}^{-1}$)
Acute	4.41E-04
Cancer Chronic	3.40E-05

Note: $\mu\text{g L}^{-1} = \text{ppb}$

Approach to Exposure Assessment

The EFED does not possess a method nor has it traditionally conducted exposure assessments for the released of pesticides to domestic wastewater from consumer uses. Therefore, EFED obtained and relied on the Office of Pollution Prevention and Toxics' (OPPT) consumer exposure model, Exposure and Fate Assessment Screening Tool (E-FAST) (Versar, 1999) to estimate Lindane concentrations in surface water. Specifically, EFED used the program's submodel designed for releases to domestic wastewater treatment, often referred to as Down-the-Drain Releases. The method assumes that in a given year the entire production volume is parceled out on a daily basis to the U.S. population and converted to a mass release per capita; daily per capita release of lindane to a wastewater treatment facility (gm/person/day). This mass is then diluted into the average daily volume of wastewater released per person daily to arrive at an estimated concentration of lindane in wastewater prior to entering a treatment facility. Lindane concentration in untreated wastewater is then reduced by the fraction removed during wastewater treatment processes before release into a river or stream.

Estimating lindane removal from wastewater treatment is accomplished through the use of basic physical-chemical properties estimated to structure activity relationships (SAR) and a POTW simulation model. OPPT's Estimation Program Interface (EPI) (SRC, 2000) which contains as part of its subroutines a POTW simulation model was used for this purpose.

After estimating removal in wastewater treatment the remaining pesticide is discharged and instantaneously diluted into surface water where no further removal occurs. Stream dilution, referred to as Stream Dilution Factor, is equal to the volume of receiving stream flow under specific flow conditions divided by the volume of wastewater released from the POTW. The resulting concentration is then used for estimating drinking water concentrations in the human health risk assessment.

Exposure Assessment and Results

Estimating Household Wastewater Releases

Production volume of Lindane marketed as consumer use was based on unpublished marketing data from the U.S. Food and Drug Administration. Data were masked, redacted, to preserve the unintended release of potentially sensitive information. Estimates were based on

concentrations of lindane in head lice and scabies treatment products, not to exceed 1% of formulation. Based on available information, this concentration equates to approximately 10 mg lindane per ml of product. Available, but sensitive, marketing data indicated that approximately 1914.6 Kg of lindane was marketed to consumers for use in head lice and scabies treatment in the U.S. during 1999-2000. This estimate was used in assessing potential exposures from this use pattern. The U.S. population is set at 2.727×10^8 (Versar, 1999). Using the formula below, the estimated daily per capita household wastewater release of lindane is **1.92E-05 gm/person/day**.

$$H_R = \frac{PdVol}{Pop} \times \frac{1000grams}{1Kg} \times \frac{1Year}{365Days}$$

Equation. 1.0

Where:

- H_R = Daily per capita release of the chemical to a wastewater treatment facility (grams/person/day)
 $PdVol$ = Production volume (1914.6 Kg/year)
 Pop = U.S. Population (The U.S. Census Bureau (1999) estimates the total U.S. population to be 2.727×10^8 persons)

Estimated Surface Water Concentrations

The estimated time-averaged surface water concentration of Lindane that may result from household release to wastewater treatment can be estimated by the following equation:

$$C_{SM} = \frac{H_R \times \frac{1}{Q_H} \times (1 - WWT) \times CFI}{SDF_M}$$

Equation. 2.0

$$C_{SH} = \frac{H_R \times \frac{1}{Q_H} \times (1 - WWT) \times CFI}{SDF_L}$$

Equation. 3.0

Where:

- C_{SM} = Median time-averaged surface water concentration $\mu\text{g/L}$
 C_{SH} = High-end time-average surface water concentration $\mu\text{g/L}$
 H_R = Daily per capita release of chemical (i.e. pre-treatment release)
 Q_H = Daily per capita wastewater volume released (364 L/person/day) (U.S. EPA, 1990; Versar, 1992)
 WWT = Fraction of chemical removed during wastewater treatment (36.98%)
 SDF_M = 50th percentile stream dilution factor for streams to which wastewater facilities discharge (980.69) (Versar, 1992)
 SDF_L = 10th percentile stream dilution factor for streams to which wastewater facilities discharge (75.44) (Versar, 1992)
 CFI = Conversion factor ($1 \times 10^6 \mu\text{g/gram}$)

Each of the above factors and assumptions are discussed below.

Daily pretreated release, H_R , is discussed above. Household wastewater volume, QH , was obtained from the 1990 NEEDS database of data on wastewater flow. The statistics used were derived from a subset of the NEEDS database for POTWs with domestic flow and a reported population served. The subset was further restricted by deleting all facilities that had wastewater flow greater than facility total flow and records that were above the 95th percentile, assumed to be outliers, of 885 liters per capita per day. Wastewater flow statistics were provided by flow category for all records selected. The household wastewater flow of 364 liters/person/day was the 50th percentile.

Fraction of chemical removed, WWT , is discussed above. A copy of the EPA SAR assessment can be found in Appendix A. The stream dilution factor, SDF_M and SDF_L is equal to the volume of the receiving stream or river under mean flow conditions divided by the volume of wastewater released from the treatment facility. SDF were calculated for all active wastewater treatment facilities reported in the U.S. EPA STORET Industrial Facility Database (IFD) using the stream dilution factor program (Versar, 1999). For this purpose, facilities with SDFs of 1.0 and less are deleted because wastewater flow dominates stream flow and is unlikely to be a local source of drinking water. Therefore the statistical distribution of SDFs is based on POTWs with SDFs greater than 1.0 (9,085 total facilities). Mean SDFs for the 10th and 50th percentile treatment facility are recommended for use in acute and chronic risk assessments.

Table 2 provides the model inputs used to estimate surface water concentrations of lindane from consumer use. Appendix B provides model results.

Table 2. E-FAST Input Parameters for Lindane

Parameters and Units	Lindane	Source
PC Code	1090001	
Production volume (Kg/Year) for 2000-2001	1914.6	Unpublished FDA data
Removal in waste water treatment (%)	36.98	http://www.epa.gov/oppt/exposure/docs/episuitedl.htm

The theoretical basis and the program for estimating environmental releases of chemicals in household products and the referenced equations can be found in the E-FAST manual located (<http://www.epa.gov/opptintr/exposure/docs/efast.htm>).

References

SRC, 2000. Estimation Program Interface, Version 3.10. Prepared for: U.S. Environmental Protection Agency, Office of Pollution Prevention and Toxics, Exposure Assessment Branch. William Meyland and Philip Howard, Syracuse Research Corporation, Syracuse, NY.

Versar, Inc. 1999. Exposure and Fate Assessment Screening Tool (E-FAST), Beta Version, Documentation Manual, December 31, 1999. Prepared for: U.S. Environmental Protection Agency, Office of Pollution Prevention and Toxics, Exposure Assessment Branch. Versar, Inc. Springfield Va. Contract No. 68-W-99-041.

Appendix A

SMILES : C(C(C(C(C1CL)CL)CL)CL)(C1CL)CL
CHEM : gamma-Hexachlorocyclohexane
CAS NUM: 000058-89-9
MOL FOR: C6 H6 CL6
MOL WT : 290.83

----- EPI SUMMARY (v3.10) -----

Physical Property Inputs:

Water Solubility (mg/L): -----
Vapor Pressure (mm Hg) : -----
Henry LC (atm-m3/mole) : -----
Log Kow (octanol-water): -----
Boiling Point (deg C) : -----
Melting Point (deg C) : -----

Log Octanol-Water Partition Coef (SRC):

Log Kow (KOWWIN v1.66 estimate) = 4.26
Log Kow (Exper. database match) = 3.72
Exper. Ref: Hansch,C et al. (1995)
Log Kow (Exper. database match) = 3.80
Exper. Ref: Hansch,C et al. (1995)
Log Kow (Exper. database match) = 3.78
Exper. Ref: Hansch,C et al. (1995)
Log Kow (Exper. database match) = 4.14
Exper. Ref: Hansch,C et al. (1995)

Boiling Pt, Melting Pt, Vapor Pressure Estimations (MPBPWIN v1.40):

Boiling Pt (deg C): 304.35 (Adapted Stein & Brown method)
Melting Pt (deg C): 56.98 (Mean or Weighted MP)
VP(mm Hg,25 deg C): 0.000506 (Modified Grain method)
MP (exp database): 112.5 deg C
BP (exp database): 60 @ 0.34 mm Hg deg C
VP (exp database): 3.52E-05 mm Hg at 25 deg C

Water Solubility Estimate from Log Kow (WSKOW v1.40):

Water Solubility at 25 deg C (mg/L): 4.044
log Kow used: 4.14 (expkow database)
no-melting pt equation used
Water Sol (Exper. database match) = 7.3 mg/L (25 deg C)
Exper. Ref: RICHARDSON,LT & MILLER,DM (1960)
Water Sol (Exper. database match) = 2 mg/L (25 deg C)
Exper. Ref: WEIL,L ET AL. (1974)
Water Sol (Exper. database match) = 0.24 mg/L (25 deg C)
Exper. Ref: WEIL,L ET AL. (1974)
Water Sol (Exper. database match) = 10 mg/L (20 deg C)
Exper. Ref: SHIU,WY ET AL (1990)
Water Sol (Exper. database match) = 8 mg/L (25 deg C)
Exper. Ref: CHEM INSPECT TEST INST (1992)

ECOSAR Class Program (ECOSAR v0.99g):

Class(es) found:
Neutral Organics

Henrys Law Constant (25 deg C) [HENRYWIN v3.10]:

Bond Method : 2.56E-004 atm-m3/mole
Group Method: 4.25E-011 atm-m3/mole
Exper Database: 5.14E-06 atm-m3/mole
Henrys LC [VP/WSol estimate using EPI values]: 4.788E-005 atm-m3/mole

Probability of Rapid Biodegradation (BIOWIN v4.00):

Linear Model : -0.0593

Non-Linear Model : 0.0000

Expert Survey Biodegradation Results:

Ultimate Survey Model: 1.5174 (recalcitrant)

Primary Survey Model : 2.8245 (weeks)

Readily Biodegradable Probability (MITI Model):

Linear Model : -0.0719

Non-Linear Model : 0.0000

Atmospheric Oxidation (25 deg C) [AopWin v1.90]:

Hydroxyl Radicals Reaction:

OVERALL OH Rate Constant = 0.5732 E-12 cm³/molecule-sec

Half-Life = 18.659 Days (12-hr day; 1.5E6 OH/cm³)

Ozone Reaction:

No Ozone Reaction Estimation

Soil Adsorption Coefficient (PCKOCWIN v1.66):

Koc : 3380

Log Koc: 3.529

Aqueous Base/Acid-Catalyzed Hydrolysis (25 deg C) [HYDROWIN v1.67]:

Total Kb for pH > 8 at 25 deg C : 6.174E-012 L/mol-sec

Kb Half-Life at pH 8: 3.558E+009 years

Kb Half-Life at pH 7: 3.558E+010 years

BCF Estimate from Log Kow (BCFWIN v2.14):

Log BCF = 2.488 (BCF = 307.5)

log Kow used: 4.14 (expkow database)

Volatilization from Water:

Henry LC: 5.14E-006 atm-m³/mole (Henry experimental database)

Half-Life from Model River: 196 hours (8.166 days)

Half-Life from Model Lake : 2281 hours (95.05 days)

Removal In Wastewater Treatment:

Total removal: 36.98 percent

Total biodegradation: 0.37 percent

Total sludge adsorption: 36.43 percent

Total to Air: 0.18 percent

Level III Fugacity Model:

	Mass Amount (percent)	Half-Life (hr)	Emissions (kg/hr)
Air	1.37	1.83e+003	1000
Water	12.5	3.6e+003	1000
Soil	80.6	3.6e+003	1000
Sediment	5.53	1.44e+004	0

Persistence Time: 2.22e+003 hr

Appendix B

INITIAL REVIEW EXPOSURE REPORT

INITIAL REVIEW EXPOSURE REPORT

CASE NUMBER: Lindane

ENVIRONMENTAL RELEASES OF CHEMICALS IN HOUSEHOLD PRODUCTS

SCENARIO #: 1

EXPOSED POPULATION:

WWT REMOVAL (%)	HOUSEHOLD RELEASE DAYS	PRE-TREATMENT RELEASE (g/person/day)	POST-TREATMENT RELEASE (g/person/day)	BODY WEIGHT (kg)	BCF (L/kg)
36.98	365.00	1.92E-05	1.21E-05	71.80	307.50

PRODUCTION VOLUME (kg/yr)	CONCENTRATION OF CONCERN (ug/L)	# DAYS CONC OF CONCERN EXCEEDED	% YEAR CONC OF CONCERN EXCEEDED	HIGH END SURFACE WATER CONCENTRATION (ug/L)	MEDIAN SURFACE WATER CONCENTRATION (ug/L)
1914.60	2.00E-02	6.67	1.83	4.41E-04	3.40E-05